Neurosymbolic AI: the 3rd wave

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Abstract

Current advances in Artificial Intelligence (AI) and Machine Learning have achieved unprecedented impact across research communities and industry. Nevertheless, concerns around trust, safety, interpretability and accountability of AI were raised by influential thinkers. Many identified the need for well-founded knowledge representation and reasoning to be integrated with deep learning and for sound explainability. Neurosymbolic computing has been an active area of research for many years seeking to bring together robust learning in neural networks with reasoning and explainability by offering symbolic representations for neural models. In this paper, we relate recent and early research in neurosymbolic AI with the objective of identifying the most important ingredients of neurosymbolic AI systems. We focus on research that integrates in a principled way neural network-based learning with symbolic knowledge representation and logical reasoning. Finally, this review identifies promising directions and challenges for the next decade of AI research from the perspective of neurosymbolic computing, commonsense reasoning and causal explanation.